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Project Summary

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Feasibility of Developing Source Sampling Methods for Asbestos Emissions

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The objective of this program was to determine the feasibility of developing methods for sampling asbestos in the emissions of major asbestos sources. The sources of concern are: (1) ore production including asbestos mining and milling and taconite production, (2) asbestos-cement production, (3) asbestos felt and paper production, and (4) the production of asbestos-containing friction materials. Potential sampling methods must provide samples compatible with the provisional analysis methods using electron microscopy (U.S. EPA Report No. 600/2-77-178).

Visits to the four industries revealed that asbestos emissions can be divided into two classes: stack and fugitive. Inherent differences between stack and fugitive emission environments may necessitate the development of two techniques or at least two modifications of a general technique for sampling. A development program for sampling methods is feasible, given the nature of the emissions and potential sampling environments observed in the industry survey.

It is not feasible to undertake a methods development program for strict compatibility with the recommended procedure of the provisional analytical method. Strict compatibility requires the collection of a uniform deposit of proper loading by air filtration on a 0.4 μm pore size polycarbonate filter. However, methods development programs are feasible if the sampling method is to be compatible with the alternative procedures of the provisional method or general electron microscopy. Such procedures require that the collected sample be transferable to an electron microscope grid for counting. The method of sample collection is not precisely specified.

Viewed on the basis of components, the essential areas for research toward method development concern collection techniques and removal of non-asbestos material. Practical options for the collection technique component are limited to either electrostatic precipitation or collection by cellulose ester or polycarbonate filters, despite their known limitations. These techniques may be supplemented by precollection with an impinger to reduce loading. The usefulness as well as the feasibility of a separation during sampling can be assessed only after more thorough data characterizing the industry emissions are obtained and evaluated. The application of inlet and probe technology appears to be a straightforward engineering task.

This Project Summary was developed by EPA's Environmental Sciences Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Asbestos has been identified as a hazardous air pollutant and is therefore subject to a National Emission Standard for Hazardous Air Pollutants (NESHAP). However, a numerical standard has not yet been promulgated, partly because of the absence of a reference source sampling method for asbestos emissions and a reference method for the analytical determination of asbestos in collected samples. A provisional analytical method has been established based upon electron microscopy (EPA/600/2-77-178). Research is continuing on the establishment of a reference analytical method based upon the current provisional method. This project is the first phase of research leading toward the possible development of a reference source sampling method for asbestos emissions.

The objective of this program was to determine the feasibility of developing methods for sampling asbestos in the emissions of major asbestos sources. The sampling methods must provide samples compatible with the provisional analysis methods. Information was gathered to make estimates of the time and effort required to develop methods.

Conclusions

After each of the key system components of a sampling system was reviewed, it was concluded that the development of a standard method for sampling asbestos emissions is feasible. The study did not uncover any limiting industry anomalies or insurmountable technical problems.

It is not feasible to undertake a methods development program for strict compatibility with the recommended procedure of the provisional analytical method. Strict compatibility requires the collection of a uniform deposit of proper loading by air filtration on a 0.4 μm pore size polycarbonate filter. However, methods development programs are feasible if the sampling method is to be compatible with the alternative procedures of the provisional method or general electron microscopy. Such procedures require that the collected sample be transferable to an electron microscope grid for counting. The method of sample collection is not precisely specified.

Inherent differences between stack and fugitive emission environments may necessitate the development of two sampling techniques or at least two modifications of the same technique.

Viewed on the basis of components, the essential areas for research toward method development concern collection techniques and removal of nonasbestos material. Practical options for the collection technique component are limited to either electrostatic precipitation or collection by cellulose ester or polycarbonate filters, although each of these options possesses negative features for the overall sampling and analysis procedure.

The negative features of cellulose ester filters include high pressure drop and sample losses in the transfer of collected asbestos to an EM grid. The negative features of polycarbonate filters include less than 100 percent collection efficiency and the tendency for collected asbestos to become detached from or to move around on the filter during handling operations. These collection techniques may be supplemented by precollection with an impinger to reduce loading. Past experience of analysts indicates that asbestos and nonasbestos material can be separated from each other in the laboratory; however, ashing, sonication, and two-phase liquid separation techniques can alter the asbestos size distribution. The usefulness as well as the feasibility of a separation during sampling can be assessed only after more thorough data characterizing the industry emissions are obtained and evaluated. The application of inlet and probe technology appears to be a straightforward engineering task.

Recommendations

A development program for a source sampling system should proceed on the basis of components. This would entail pursuit of research both on collection techniques and extraneous material separation during sampling. Subsequently the most promising of the techniques should be incorporated with each component and with state-of-the-art inlet and probe designs to form a sampling system. Finally the complete system must be checked in the laboratory and demonstrated in the field.

Investigation of collection techniques should center on electrostatic collectors and on collection by cellulose ester and polycarbonate filters, despite the limitations of each of these options. More industrial data characterizing the extraneous material need to be obtained to assess whether a development program for removal of extraneous material should focus on separation during sampling, in the laboratory, or both. The advantages of precollection with impingers or other means to reduce loading should be evaluated experimentally.

Determination of Criteria and Constraints

A source sampling method for asbestos emissions must meet certain requirements if it is to be accepted as an approved sampling method. Two standards upon which to base a judgment of acceptability were determined at the outset of the program. The first criterion is that the sampling method must be capable of collecting a representative asbestos size distribution from the local environment. The second criterion is that the asbestos must be collected so that it can be analyzed by the provisional analytical method to provide the required determinations.

A number of constraints arising from different sources restrict potential sampling methods if they are to meet the two basic criteria. The establishment of these constraints provided the framework for the conduct of the feasibility study on the development of a source sampling method.

After identification of general constraints on a sampling method, the following factors were reviewed:

- characteristics of asbestos fibers
- composition and magnitude of emissions potentially containing asbestos
- characteristics of potential sampling environments
- current source sampling methods
- analytical methods for asbestos determinations
- adaptability of particle collection methods for asbestos.

The evaluation included a literature review and site visits to the four industries. Consideration of the findings of the overall review coupled to the two general criteria for a source sampling method led to the identification of the constraints on a method for asbestos. They are:

- A single collector cannot be used simultaneously to collect asbestos over the diameter range 0.03 to 10 μm and to provide optimum loading for both number and volume concentrations by counting.
- The potential breakup of fiber bundles must be minimized by providing a short, straight transport path between the sampling inlet and the collector.

- The difference in air velocity between stack and fugitive emission environments necessitates the development of at least two sampling techniques designed for air velocities in the two types of environments.
- Saturated conditions will be encountered. The sampling system must be able to collect samples in these environments.
- A continuous monitor to assess the level of asbestos loading in the collector is not practical. A series of sample volumes should be collected separately to provide one with an acceptable loading.
- Strict compatibility with the recommended practices of the provisional method is not possible if collection methods other than air filtration by polycarbonate filters are to be considered.
- If the sampling method is to be strictly compatible with the provisional analytical method, the sampling rate through the filters must be within the range for optimal filtration by a polycarbonate filter.
- Direct air filtration or filtration of a liquid containing collected asbestos is feasible. Uniform electrical deposition of asbestos on a surface needs further research.
- The size and chemical characteristics of the asbestos and nonasbestos particulate emissions preclude the use of inertial or magnetic forces in a sampling system for material separation. It is highly probable that material separation techniques will need to be used during sample preparation.

Elevated temperature is not a constraint.

Feasibility of Method Development

The feasibility of conducting a development program for an asbestos source sampling method was determined by considering four components of a sampling system. These components are: (1) system inlet, (2) transport probe, (3) extraneous nonasbestos material separation, and (4) collection technique.

The current technology for design of inlets and probes for sampling particulate matter is adequate. The application of this technology to an asbestos sampling method is a straightforward engineering task for both fugitive and stack sampling applications.

Undesirable nonasbestos material (extraneous material) will be present in the sampling environment, thus complicating the measurement of the airborne asbestos. Ideally, the extraneous material should be removed at the time of sampling to facilitate subsequent analysis.

Classically, extraneous material has been removed by employing differences in either physical or chemical form to separate the undesired material from the material of interest. The broad size range of asbestos present [from the diffusion dominated region (0.03 μm) to the inertial behavior region (4.0 μm)] makes complete separation of extraneous material from the asbestos impossible by traditional mechanical means such as impactors or cyclones. The apparent nonhomogeneous form of the extraneous material makes other types of separation (such as magnetic or metallic material) impractical. Thus, at this time, it would appear that chemical or pyrolytic separation of the nonasbestos material holds the most promise. Such techniques are more appropriately suited to analytical procedures than sampling procedures and as such were not within the scope of this study.

The following collection techniques were reviewed: (1) direct detection based on electrical mobility, inertial separation, and phase distribution of light scattering and (2) fiber collection by thermal and electrostatic precipitation, collection by impingers, air filtration, and collection by cyclones. Practical options for a collection technique are limited to air filtration using polycarbonate or cellulose ester membrane filters or electrostatic precipitation.

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The complete report, entitled "Feasibility of Developing Source Sampling Methods for Asbestos Emissions," (Order No. PB 82-196 148; Cost: $9.00, subject to change) will be available only from:
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